

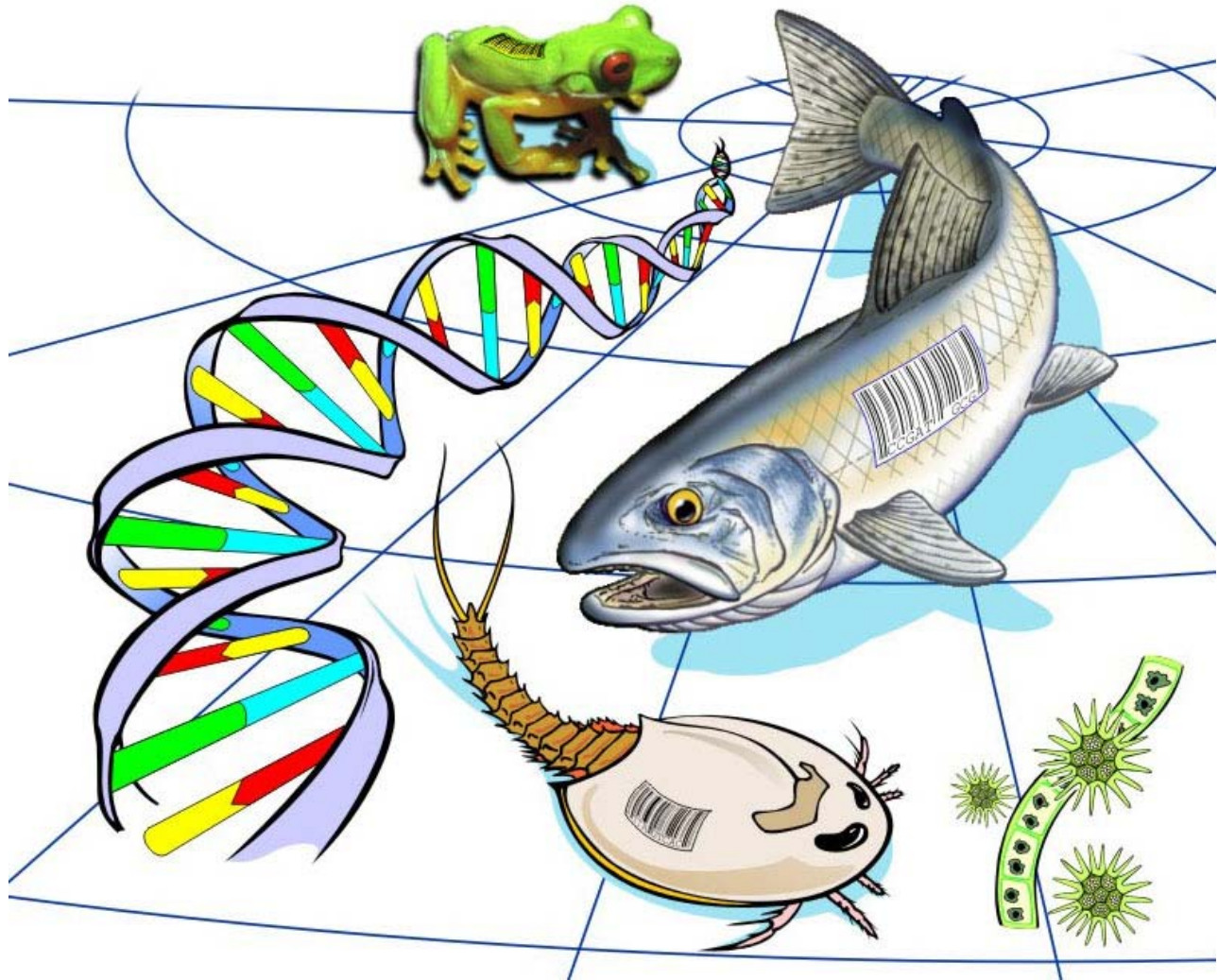
Biological Identifications, DNA Barcodes and Biosecurity

Paul Hebert

Scott Miller

NMNH

Smithsonian



Human Zoonoses

- 61% of all infectious disease agents
- 75% of all emerging diseases
- 0.5B live vertebrates imported/year







International Trade and Biological Invasions

Recent Invaders - The \$500M Club



**Zebra
Mussel**



**Emerald Ash
Borer**

Identifying Life



OUR PLANET:
Home to approximately
10 - 100 million species.



OUR MIND:
Able to recall & recognize
perhaps 1000 species.

DNA Barcode:

short sequence enabling species discrimination



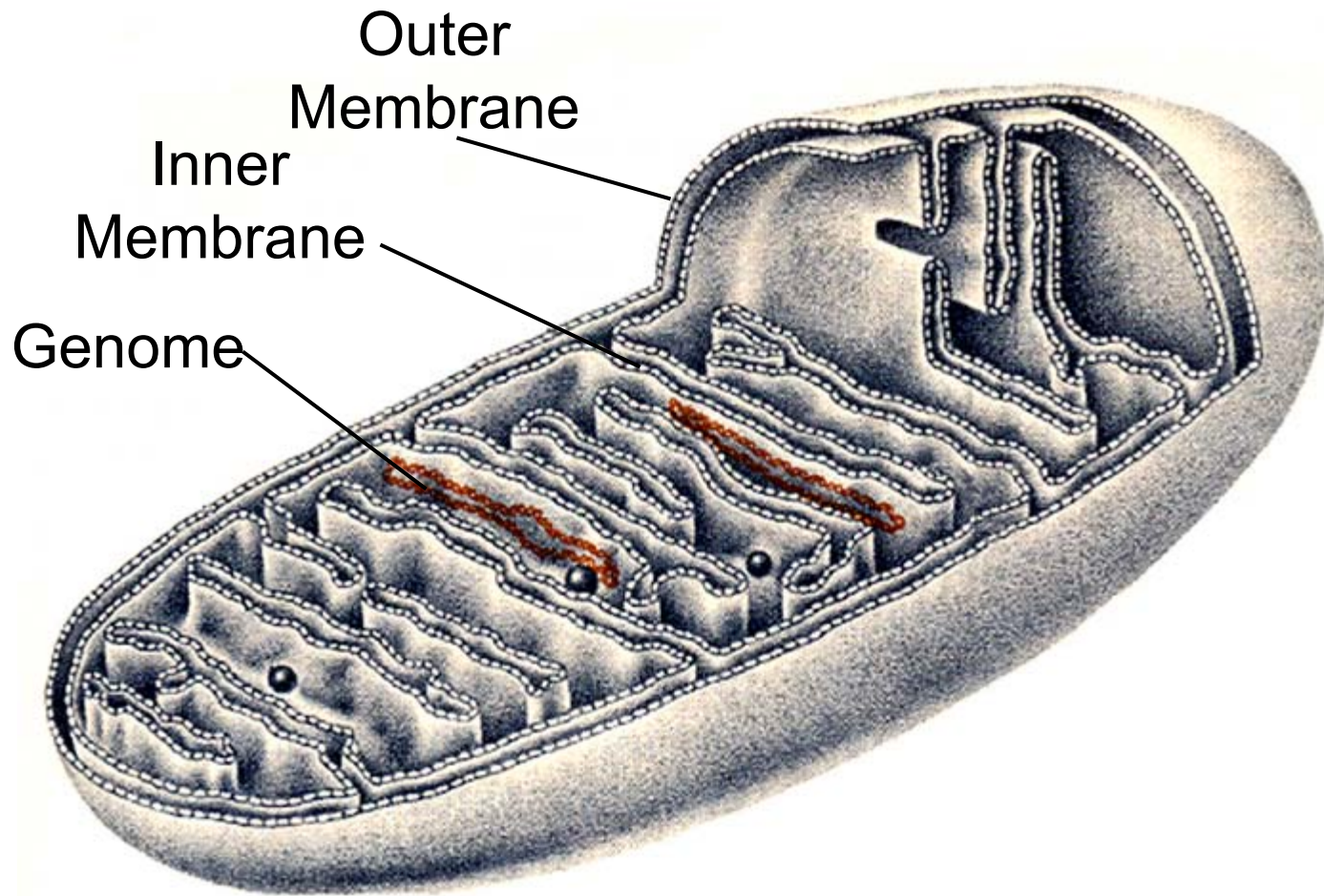
Diagnosing Species



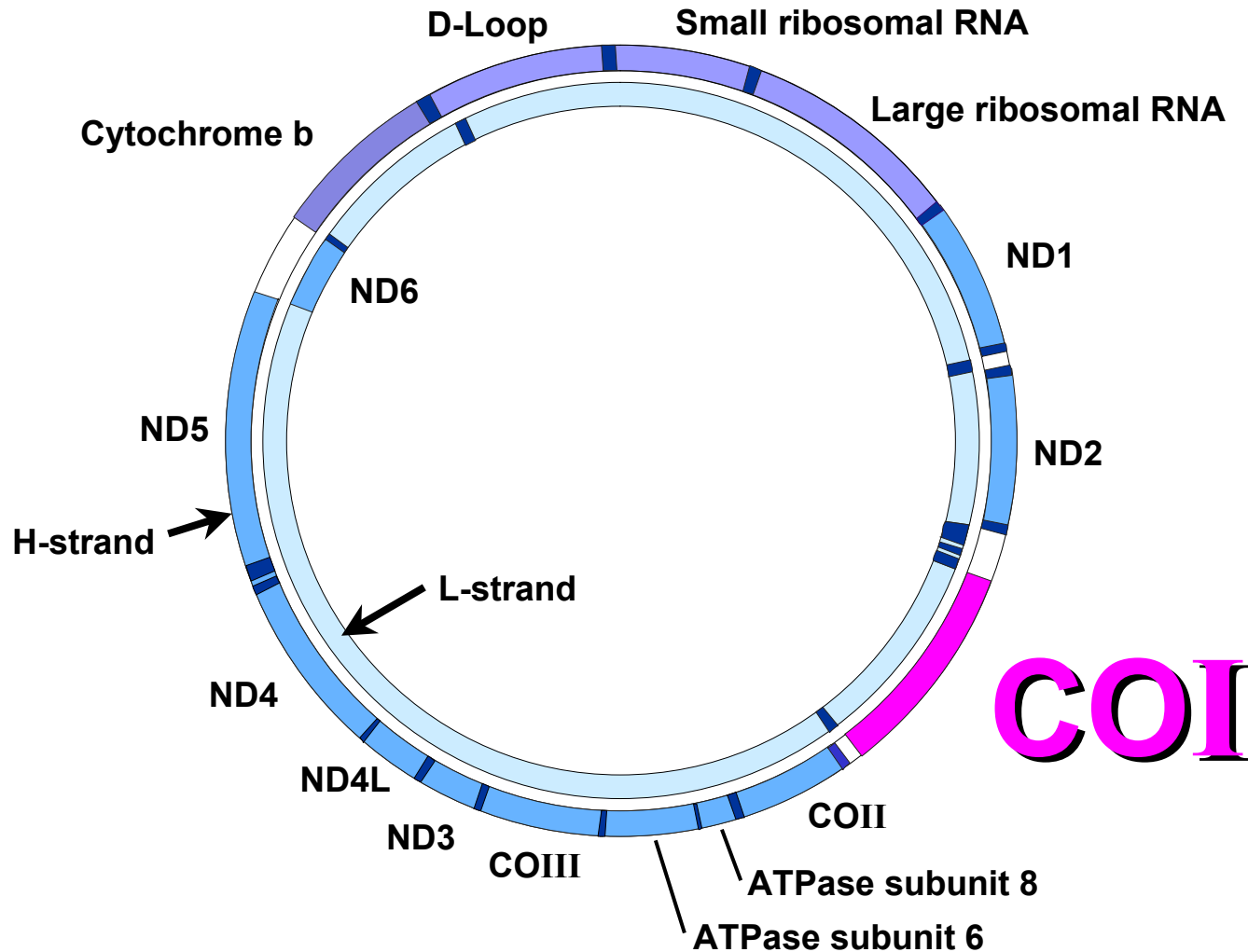
Rate of sequence change: 1% per Million years

Expect 10 diagnostic substitutions/kb/My

The Mitochondrion & its Genome



The Mitochondrial Genome

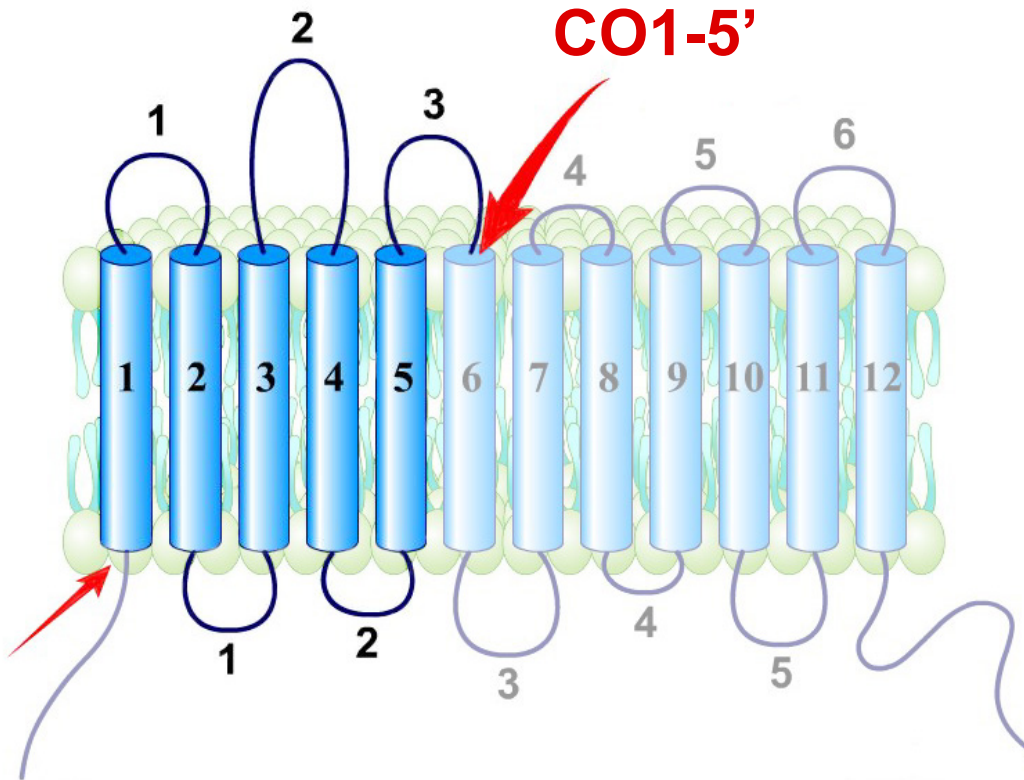


Tissue Sample

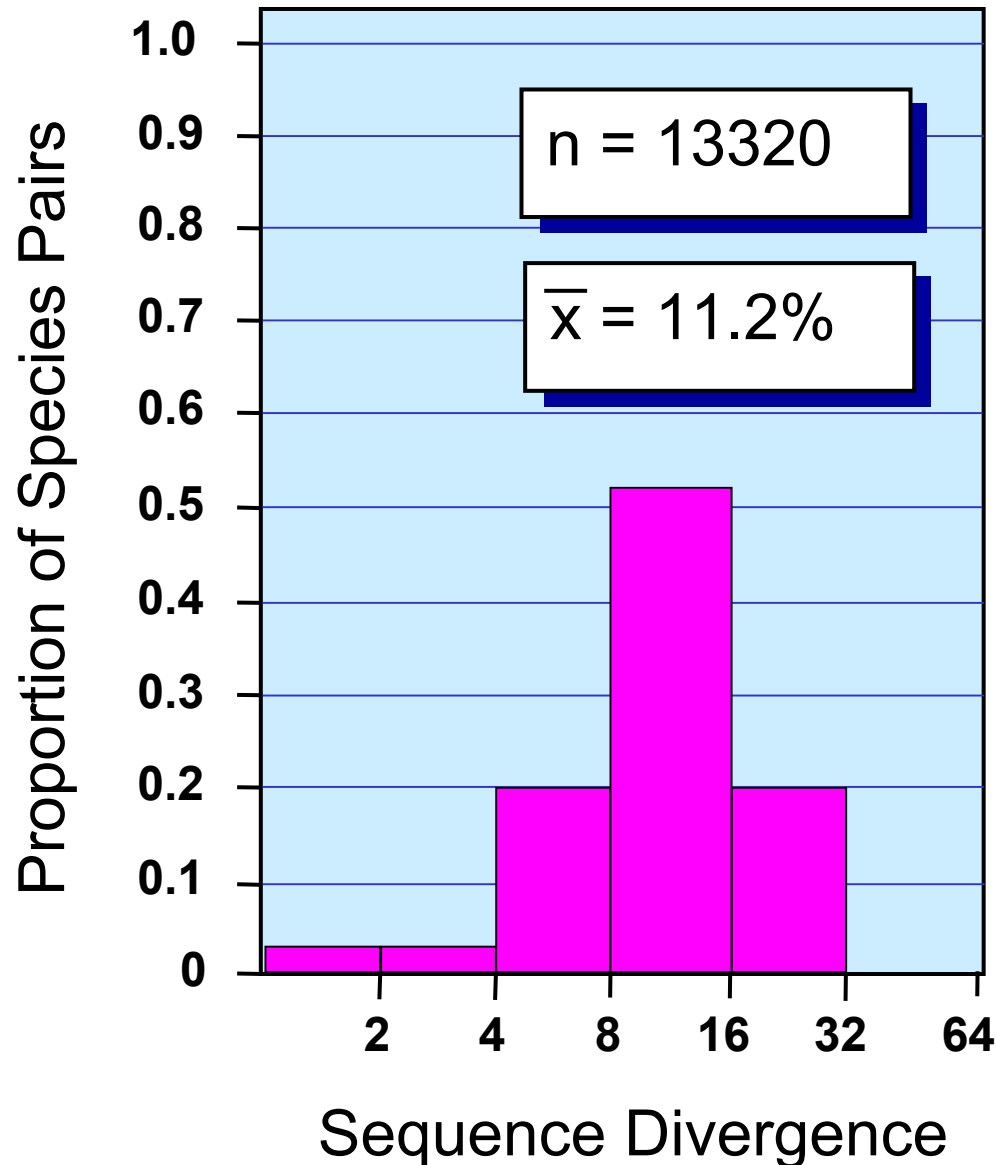
Extract DNA

PCR COI

Sequence COI



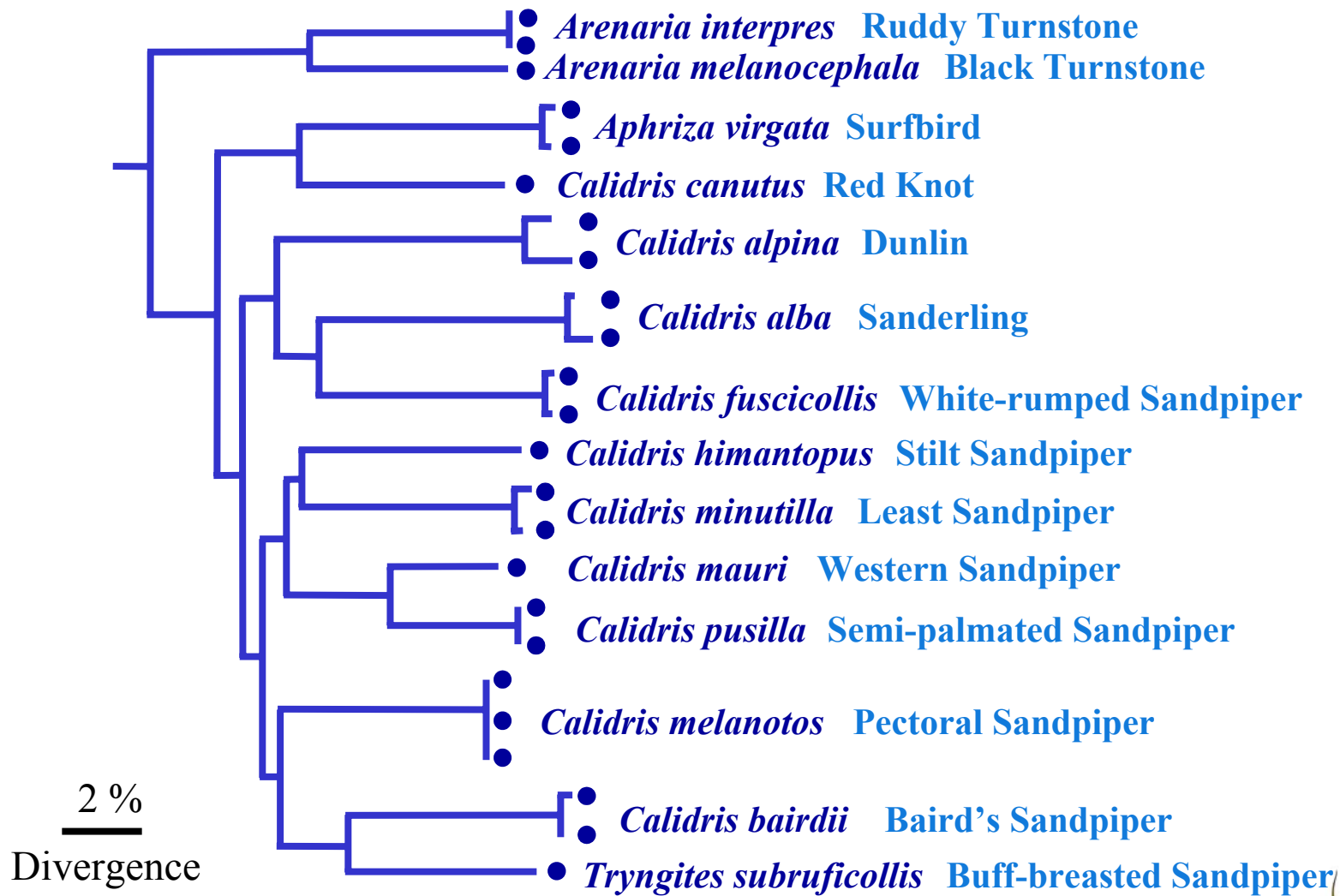
COI Divergences (%) in Closely Related Animals



Sensitivity analysis on large phyla







Bird Identification through DNA barcodes



Birds Strikes and Barcodes

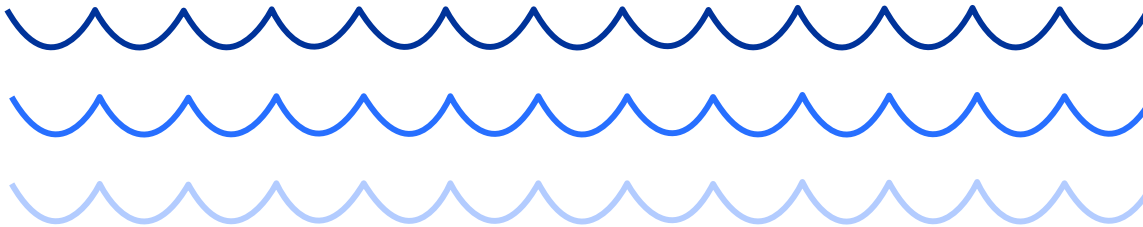


COI Divergences (%)

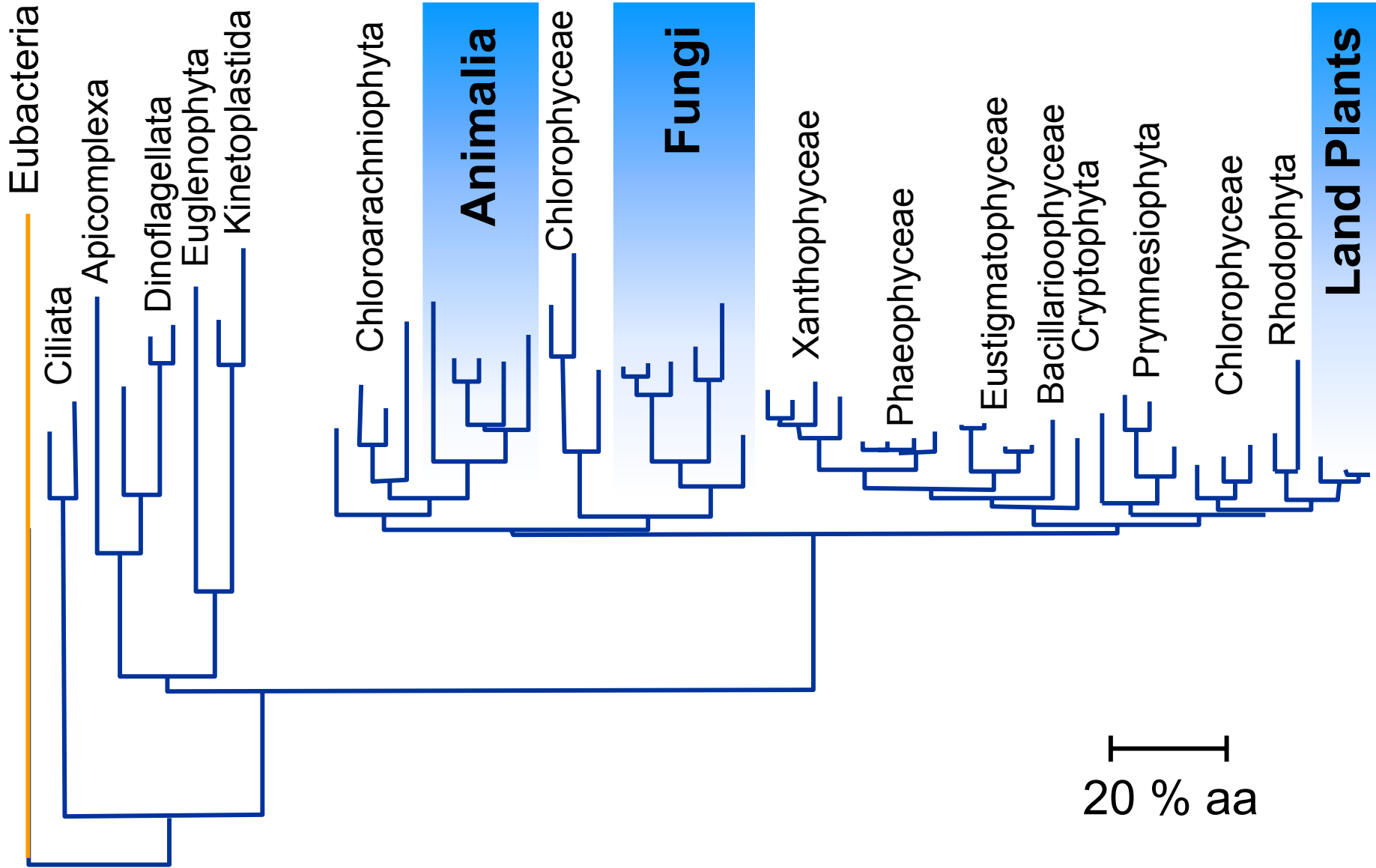
GROUP	WITHIN SPECIES	BETWEEN SPECIES	RATIO
Saturniidae	0.25	9.52	38.1
Sphingidae	0.22	7.06	32.1
Noctuidae	0.36	6.30	17.5
Ephemeroptera	0.34	15.36	45.2
Odonata	0.56	10.90	19.5
Hymenoptera	0.29	11.90	41.0
Collembola	0.09	14.97	166.3
Aves	0.30	7.27	24.2

Barcoding Animals (10M species)

- Effective in varied geographic settings
- Effective in varied taxonomic groups
- 99.999995% resolution



COI Divergence in Eukaryotes



Taxonomy, DNA, and the Barcode of Life
Banbury Center, Cold Spring Harbor Laboratory, NY
September 10-12, 2003



Taxonomy, DNA, and the Barcode of Life

Meeting held at Banbury Center, Cold Spring Harbor Laboratory,
New York, NY September 10-12, 2003

Sponsored by the Sloan Foundation

Imagine a world in which any person, anywhere, at any time can identify any species at little or no cost. That world is technologically upon us. This report addresses the formative stages of an initiative to bring this to society sooner rather than later

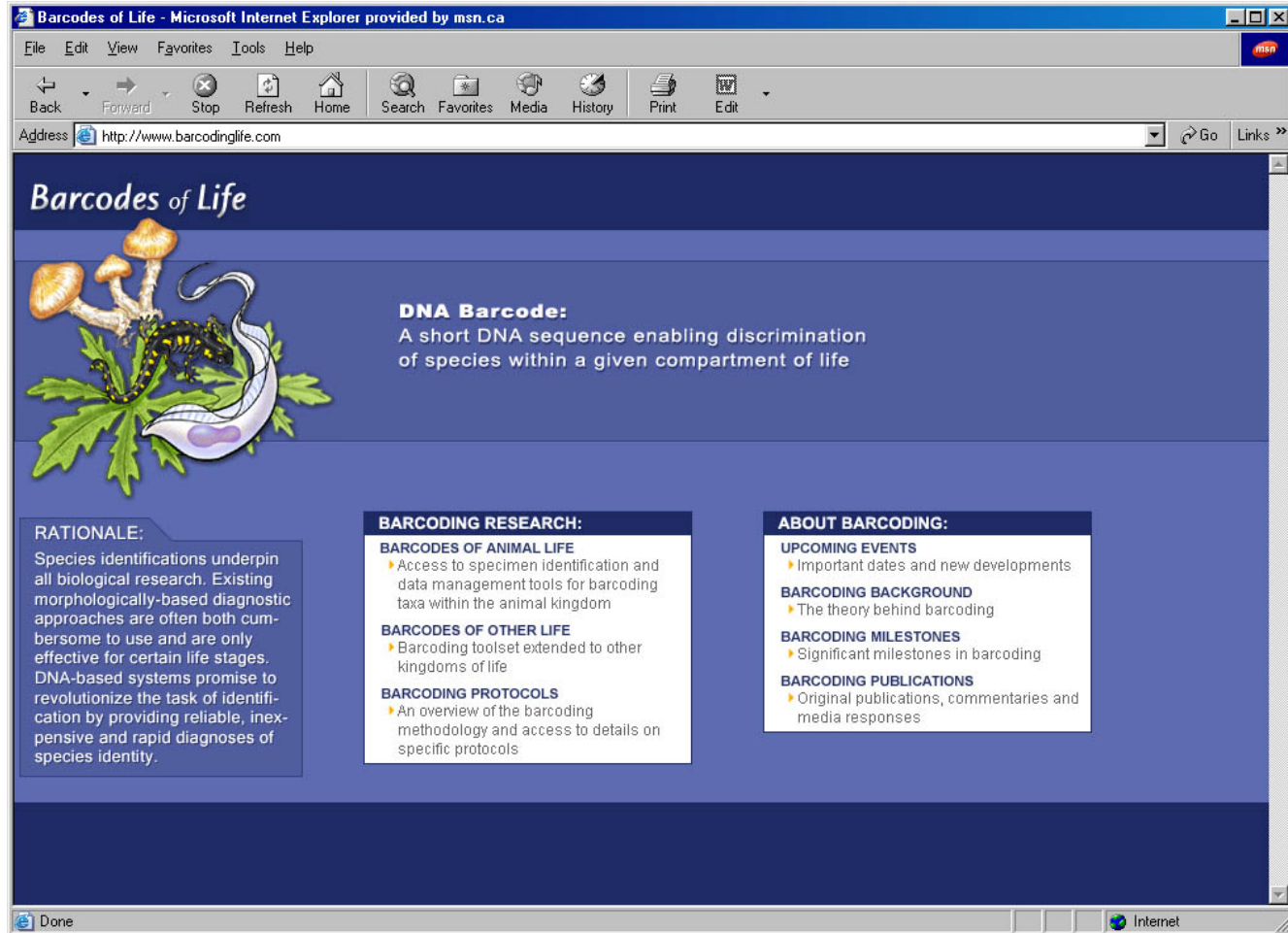
Barcode of Life Secretariat



- **Barcoding all eukaryotes**
- **Launch April 2004**
- **Costs circa \$2B**
- **Databasing underway**

Barcodes of Life Database (BoLD)

www.barcodinglife.com



10 million species files, 50 million specimen files

Barcoding - The Future



Global Bio-ID System



- **Biosecurity**
- **Forensics**